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54 **System for measuring objects viewed through a borescope.**

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Description

Background of the Invention

This invention relates generally to a borescope or endoscope for providing a full color video image of a generally inaccessible object, and more particularly to a system for measuring the size of objects viewed on the video image display of the borescope.

Various devices have been provided in the prior art for realizing a full color video picture of a target situated within a remote cavity. These devices have been gradually improved over time to where today most devices of this type employ an external light source conveyed to the image head by fiber optic bundles together with a solid state image sensor and lens system positioned in the distal end of the insertion tube of the borescope/endoscope connected to an external video display. A particularly compact head including a light source and solid state image sensor lens system of this type is shown in U.S. Patent 4,491,865 to Danna et al. which patent is owned by a common assignee of the present applicant.

Generally, in systems of this type, the fiber optic illumination bundle and the image sensor and optical system are disposed side by side in the end of a small insertion tube adapted to be inserted in cavities for viewing objects therein. The light provided by the fiber optic bundle has a field of view slightly displaced from the optical field of view of the image sensor, but generally overlapping sufficiently to provide an effective field of vision for the device. The image detected by the image sensor is displayed on a video screen and will vary in magnification, apparent size, and detail, depending upon how close the end of the insertion tube carrying the lens system is from the object being viewed. Generally speaking, devices of this type have a depth of field from 0,32 cm (an eighth of an inch) to something over 2,5 cm (one inch). The real close images, of course, have the greatest magnification and the more distant images the least.

Such a device is for example disclosed in DE-A-3 516 164, in which a concentric ring image is projected at a projection angle corresponding to that of the optical field of view lens, so that there is a known length between the extreme edge of the field of view and the maximum displacement of the top of the image of the circle. This known distance is used to calibrate the display for a given object distance and the size of the object is determined by reference to this known distance. Thus it is not possible to determine object size, if the plane of the object is not perpendicular to the optical axis.

It has also been proposed, i.e. in DE-A-3 629 435 a device in which the relative displacement of an auxiliary spot created by an auxiliary light source is projected at a known angle, so that displacement of the dots can be used to calculate object distance. Beyond

the fact that such a device requires an auxiliary light source, the object distance can only be calculated such as in the prior one, when the object lies in a plane perpendicular to the optical axis. A tilted object thus cannot be measured with this device.

Heretofore, all attempts to measure the image on the video display to determine the size of the object being viewed have had to rely on either the placing of a known scale adjacent to the image to be measured for a comparison measurement, or the provision of a physical standoff over the lens on the end of the borescope insertion tube at which point the magnification is known and then actually adjusting the end of the borescope until it just touches the object to be viewed at the standoff. With this known magnification, the image can be measured on the screen and the precise size determined.

Objects and Summary of the Invention

Obviously, this method of measurement has been somewhat awkward and time consuming and it is therefore an object of the present invention to provide a system for measuring objects viewed with a borescope video sensor and lens system that allows measurement without the necessity of placing scales adjacent the object to be measured or use of physical standoffs to determine the object distance from the lens system.

It is another object of the present invention to provide an object measuring system that is self-contained and integral with the illumination and sensor systems of a borescope.

It is a further object of the present invention to provide an object measuring system for a borescope or the like that can be operated entirely externally of the cavity into which the borescope insertion tube is placed.

It is a further object of the present invention to provide an object measuring system for measuring the size of an object directly off the video display screen of a borescope.

It is a further object of the present invention to provide an illumination system for a full color video image device that additionally provides a measuring indicator for determining object distance from the lens assembly of the video imaging device.

It is further object of the present invention to provide an illumination system including a shadow creating means for automatically indicating the object distance on a video display screen.

It is a further object of the present invention to provide an illuminating system for use in a video imaging device that includes projecting an image of known size and shape through the viewing field of the imager device so that the image size on the video display screen will indicate the object distance from the lens system.

It is a further object of the present invention to provide an illumination system for general illumination of the object to be viewed and for special measurement illumination of a known pattern that will indicate magnification, and thus object distance from the lens assembly.

It is a still further object of the present invention to provide an object measuring system for electronically measuring the size of an object being viewed with a borescope.

It is yet a further object of the present invention to provide an illumination system for a video imaging device in which a constant size ring image is projected on the object to be measured so as to indicate object distance from the lens system.

Brief Description of the Drawing

These and other and further objects of the invention, together with additional features and advantages accruing therefrom will be apparent from the following description of a preferred embodiment shown in the accompanying drawings in which like reference numerals indicate corresponding parts throughout wherein:

Fig. 1 is a partial sectional view of the imager head of a borescope according to the present invention showing in diagrammatic form the principles of the present invention;

Fig. 2 is an enlarged end view of the imager head of the borescope of Fig. 1 in accordance with the present invention;

Fig. 3 is an elevation of a display screen and calibrated scale for a particular imaging system showing the relationship between magnification and object distance from the image detecting lens system;

Fig. 4 is a display screen similar to Fig. 3 with an object to be measured showing electronic cursors for measurement of the object to be measured;

Fig. 5 is a schematic and diagrammatic representation of another embodiment of the present invention;

Fig. 6 is an enlarged end view of the imager head of a borescope in accordance with the invention of the embodiment of Fig. 5; and

Fig. 7 is a display screen showing the use of the embodiment of Figs. 5 and 6 for measuring objects on the display screen.

Figs. 8A and 8B are diagrammatic showings of the shadow means of Fig. 1.

Detailed Description of the Invention

Referring now to Fig. 1 there is shown a borescope imager head 10 having a fiber optic illumination source 12 and a video image sensor channel 14

with associated lens system 16 positioned in the end of the insertion tube of a borescope. As described in the prior art, the optical fiber source 12 provides a general illumination which may be single or full color and which illuminates an area shown diagrammatically as arc 18 emanating from the face of the fiber optic source. The field of view of the imaging device is determined by the lens system and its juxtaposition with the solid state sensor device, and is represented by arc 22 in Fig. 1. In the particular embodiment of the present invention, the fiber optic source is configured in a thin strip 19 shown in Fig. 2 extending across the fiber optic channel in a planar fashion. This configuration provides enough general illumination in as fully an effective manner as the more conventional circular fiber bundles. Positioned a spaced distance in front of the termination of the fiber optic thin strip 19 is an opaque index element or bar 20 which extends the full width of strip 19 and casts a shadow image from the illumination emanating from the fiber optic strip onto the objects being viewed. The standard lens system generally is shown directly below the illumination system in Fig. 2.

The shadow cast by index bar 20 will fall on objects within the field of view of the imager channel 14 depending upon how far the object is from the imager lens. An object near the lens such as at line 24 will have the shadow 21 from bar 20 close to the edge which, in Fig. 3 is translated to the left edge of the screen. An object farther away from the lens such as at line 26 will have the shadow from bar 20 falling further down in Fig. 1 or to the right in Fig. 3 and when the image of the object is projected on the display screen, the shadow will be displaced to the right such as shadow 23 in Fig. 3. Shadow 27 represents the limit of the measurement range of the borescope.

An object located at line 24 will appear on the video display as a relatively large object, while the same object at line 26 will appear quite small on the display. The shadow 23 will actually be wider in the line 26 display than the shadow 21 in the line 24 display because of the divergence of the light from fiber optic strip 19. The shadow will appear to remain substantially the same width as it traverses across the display.

Referring now to Fig. 3 there is shown a video display screen for the imager system of the borescope head. Shown in an overlay on the screen is a magnification and object distance scale (29) calibrated for the particular display screen based on the geometry of the particular borescope head, illumination source, imager lens, and detector system. The particular calibration shown is for a 33 cm (thirteen inch) video display screen and a borescope head illumination pickup system wherein when the imager head is placed approximately 0,32 cm (an eighth of an inch) from the screen, the magnification of that image is something on the order of twenty-five times actual size when

displayed on the video display screen. Conversely, when the imager head is about 1,3 cm (half an inch) from the object being viewed, the magnification will be reduced to a factor of about nine. The maximum depth of vision for borescopes of this type is something in the neighborhood of 2,5 cm (one inch) which, in this configuration, yields a magnification of about five.

Referring again to Fig. 1, it will be seen that the shadow bar 20 is positioned off-center of the illumination field so that it will cast a shadow across the field of view of the lens system at different positions from left to right on the display screen of Fig. 3 and as represented in Fig. 1, from top to bottom. Thus, as shown diagrammatically in Fig. 1, the shadow 21 when looking at an object placed at the position of line 24, will just touch the edge of the field of view and it will appear on the left side of the display screen of Fig. 3. If the above lens system for picking up the image is spaced only 0,25 cm (0,1 inches) or so from the object itself, the image will be highly magnified on the display screen of Fig. 3. The shadow created by shadow bar 20 will be all the way to the left of the presentation in Fig. 3, indicating that the image pickup lens system is approximately 0,35 cm (0,140 of an inch) from the object being viewed in this system. The scale in Fig. 1 has been exaggerated for clarity of presentation, but the actual numbers for a particular borescope and display screen are as indicated on the overlay in Fig. 3.

Looking again at Fig. 1, it will be seen that as the field of view of the image device and lens system expands, as you go further from the face of the lens, the shadow created by the shadow bar 20 from the light source 12 will appear to move to the right on the display screen or to the bottom of Fig. 1. The distance that this shadow moves from top to bottom in Fig. 1 or left to right in Fig. 3 is proportional to the distance the object being viewed is from the face of the lens system. This geometric distance has been related, for the specific embodiment of the present invention as shown in Figs. 1 and 3, to the overlay on the screen which shows in scale form the magnification and object distance for this system from the very closest visualization to the most distant, for this particular light source and lens system. It is thus possible to determine the distance from the object being viewed to the lens face by noting where the shadow falls on the calibrated scale. This will translate into cm or inches, and at the same time it will indicate the magnification of the object at particular location of the shadow.

The system described can be used in a variety of ways to make measurements of objects being viewed. To make a measurement in the plane of the image of an object i.e., a plane at right angles to the axis of the lens system, the first step would be to note the area where the shadow falls on the image of the object being measured. If for instance the shadow

falls at the location on the display screen at ten magnification, which means that the lens system is 1,2 cm (.475 inches) from the object being viewed and that the object is magnified ten times larger than it actually is, then by measuring the image of the object on the display screen with vernier calipers or similar measuring device and dividing by ten, the actual size of the object being viewed by the borescope will be obtained.

Similarly, if the object being measured is a hole or a scratch 25 or other depression in the surface, there will be found a "blip" 28 in the shadow line, and instead of being a straight line as shown at 24, it will be a notched or displaced line, as shown at 28 in Fig. 3. The difference between the main portion of the shadow 26 and the displaced blip 28, when measured on the calibrated scale of distance, will show the depth of the indentation. If the actual surface dimensions of the depression are desired, they can be physically measured on the display screen with a vernier caliper or other scale and then divided by the magnifications indicated at the location of the shadow on the scale to obtain the actual physical surface size of the depression.

In another embodiment of the present invention, instead of physically measuring the size of the image on the display screen, one may electronically measure the object by use of one or more cursors that may be set at each edge of the object. Thus, as may be seen in Fig. 4, if the object 30 is to be measured, a first cursor 32 is positioned at the left edge and a second cursor 34 is positioned at the right edge. The pixels between cursors 32 and 34 are then electronically counted, translated into inches or other suitable measurement, and displayed on the viewing screen or recorded as the case may be. The size translation is accomplished by noting the position of the shadow and the magnification which is used to convert the pixels to physical dimensions. Electronically this can be done by a first step of positioning cursor 32 at the shadow and electronically counting pixels from the left edge of the screen to the cursor 32. While the foregoing examples have been shown with the shadow created by shadow bar 20 moving from left to right in Fig. 3 or top to bottom in Fig. 1, the system could be set up so that the shadow would move from top to bottom in Fig. 3 or any other convenient arrangement.

Referring now to Figs. 5, 6, and 7, there is shown another embodiment of the present invention. This embodiment involves the projection of a constant diameter ring image of a known diameter out of the head of the borescope and into the viewing field of imager channel 14' so as to impinge on the object to be viewed at whatever distance it may be from the borescope head. By projecting a constant diameter ring, the apparent size of the ring will change at the video display as the borescope head is moved from very closely adjacent the object to the maximum distance

the image can be seen. However, as shown in Fig. 7, we will now have a center which is the zero point and the extremities which are the maximum magnification.

By noting the apparent size of the ring as projected on the display screen, one can determine the magnification, and by measuring the size of the object on a display screen and dividing by the magnification, the actual dimension of the object being measured can be determined. The concept is similar to that shown in Figs. 1-3, namely by noting the change in diameter on the display screen of the ring instead of the displacement of the shadow from left to right, the distance to the object from the lens system is known and directly related through the geometry of the system to the magnification of the object being viewed and thus, the actual physical size of the object being viewed.

In this embodiment, shown in Fig. 5, there is provided a general illumination source 40 which is fed through a lens system 42 to circular fiber optic bundle 44 (Fig. 6) extending through the insertion tube 46 to the image head of the borescope. This source 40 provides general illumination throughout the field of view of the borescope as shown by the dotted lines 48 in Fig. 5. The video imager field of view is indicated by lines 50.

Superimposed upon this general illumination is a source 52 of coherent laser-like light which is projected via mirror 54 through the fiber optic cable 46 to the borescope head. The laser light emerges from the head in a coherent circular beam 56 of light the diameter of which remains essentially constant throughout the depth of field of the borescope. The general source of illumination is emitted from the circular fiber optic termination so that it provides a broad cone of illumination for the target area of the objects to be viewed. The laser light, which is colored for easy detection, is superimposed on the general illumination, and appears on top of the general image of the object being viewed at the video display.

As can be seen in Fig. 5, as this ring is projected upon the image of the object being viewed at the display screen, it will appear at image distance 58 to be a large percentage of the field of view represented by rectangle 59 and at image distance 60 a smaller percentage of its field of view represented by rectangle 61. By noting the difference in circle size on a pre-calibrated overlay 62, shown in Fig. 7, one can readily determine the object distance from the lens which gives the magnification, and thus the actual physical dimension of the object being measured can be determined from physical measurement of the video screen image.

Thus, in Fig. 7 the defect 64 physically measures 1.5 inches across and the ring 66 indicates a magnification of 18. Therefore, the defect actually is .083 inches across in the object being viewed. If the dotted

line ring 66' were used, a magnification of ten would be shown, resulting in an actual size of .150 inches. Similarly in Fig. 4 the defect 30 measures 1.5 inches on the display screen and the shadow 26' indicates a magnification of six so the actual size of defect 30 in the object being viewed is 0.62 cm (.245 inches).

In Fig. 4 this can also be determined directly from the overlay by noting the object distance at each end of the defect and subtracting one from the other. This, of course, assumes that the object is in a plane essentially perpendicular to the axis of the video imager channel 14 optical lens system.

Again, the size of the ring can be measured electronically by counting pixels in a manner similar to that for the embodiment of Figs. 1-3, and with cursors such as in Fig. 4 the size of the object can be determined automatically and displayed on the video screen.

The embodiment of Figs. 5-7 has a further advantage in that it allows the construction of an extremely small diameter borescope insertion tube. For instance, in one preferred embodiment the video imager lens system has a diameter of approximately five millimeters. The optical fibers and the physical encapsulation of the fibers add about one more millimeter so that the total diameter of the borescope insertion tube becomes approximately six millimeters. This is considerably smaller in diameter than the system of Fig. 1 or other known systems today.

In the embodiment of Figs. 1-3, the shadow bar 20 preferably is of a size slightly thicker than the thickness of the fiber optic strip 19 so that the shadow 70 cast on the screen will be a solid black shadow regardless of the distance from the image head within the depth of field of the borescope image system. (Fig. 8A). If the shadow strip 20 is narrower than the light source strip, it is possible that the shadow would be lost at a more distant object location. (See Fig. 8B).

Obviously the more dense and crisp the edge of the shadow is when projected on the object and on the display screen, the more accurately one can measure the objects under consideration. This relative size limitation is not encountered in Figs. 5-7.

While this invention has been explained with reference to the structure disclosed herein, it is not confined to the details as set forth and this application is intended to cover any modifications and changes as may come within the scope of the following claims.

Claims

1. A device for measuring the actual size of an object being viewed on a video display screen in which a source of illumination (12,40) for the object and a borescope imager head (10) are disposed in a housing and operatively connected to a video display system including said video dis-

play screen, comprising

- auxiliary image creating means (20, 52) operatively associated with the borescope imager head (10) for projecting an auxiliary image (21, 66) on the object to be viewed, said image creating means (20, 52) being disposed to cause the auxiliary image created (21, 66) to change in size in proportion to the distance the object to be measured is from the borescope imager head (10) said change in size corresponding to a change in location of the auxiliary image (21, 66) on the video display screen; and
- pre-calibrated scale means (29) overlayed on the video display screen for identifying the location of the auxiliary image (21, 66) on the screen and for determining a magnification factor associated with the identified location of the auxiliary image on the screen so that the distance of the object from the borecope imager head (10) is obtainable from said scale means independently of the orientation of the plane containing the object relative to the optical axis of the lens system

(16) .

2. The device for measuring the actual size of an object being viewed on a video display system as described in claim 1, further characterized in that the actual size of the object is calculatable by dividing the size of the image of the object as measured on the screen by the determined magnification factor.
3. The device for measuring the actual size of an object being viewed on a video display system as described in claim 1, further characterized in that the actual size of the object is calculatable by subtracting the object distance on the scale means (29) that is associated with one end of the image of the object on the screen from the object distance associated with the other end of the object image when the viewed object is in a place substantially perpendicular to the optical axis of the lens system (16).
4. The device for measuring the actual size of an object viewed with a video display system as described in any of claims 1 to 3 further characterized in that the illumination source (12) comprises a thin strip of fiber optic material (19) having a width substantially greater than its thickness, and said auxiliary image creating means (20, 52) comprises a shadow bar (20) positioned closely adjacent the end of said thin fiber optic strip (19) and offset from the center line of the field of illumination so that a shadow line (21) is created on

the object being viewed and in the image thereof displayed on the video display screen.

5. The device as described in any of claims 1 to 3, further characterized in that the contrasting image creating means (20, 52) comprises a source of colored coherent laser-like light (52) projected to form a ring of constant diameter coherent laser-like light (66) on the object to be viewed and in the image thereof displayed on the video display screen.
6. The device as described in any of claims 1 to 5, further characterized in that said pre-calibrated scale means (29) is calibrated as a function of the particular video display screen and the geometry of the specific borescope imager head (10), illumination source (12, 40), imager lens (15, 42) and a detector system such as a video image sensor channel (14).
7. The device as described in any of claims 1 to 6, further characterized by circuit means including cursors (32, 34) for performing the measurement of the image of the object displayed on the video display screen by electronically counting the pixels between the cursors (32, 34) when one of each of the cursors (32, 34) is positioned on one of the opposite ends of the diameter of the image of the object desired to be measured.
8. A method for measuring the actual size of an object viewed on a video display screen associated with a borescope having a general source of illumination (12, 40) and an image detecting device (14) positioned in a borescope imager head (10) being mounted on the distal end of the borescope insertion tube (46), said method comprising the steps of:
 - creating an auxiliary image (21, 66) by either interposing a shadow bar (20) between the general source of illumination (12) and the object to be viewed to create the auxiliary image (21) or superimposing a colored coherent laser-like light (52) around the general source of illumination (40) to create the auxiliary image (66);
 - projecting the auxiliary image (21, 66) onto the object to be viewed;
 - displaying the image of the object and the auxiliary image (21, 66) received by the detecting device (14) on the video display screen;
 - allowing the auxiliary image (21, 66) to change location on the video display screen as a function of the distance between the borescope imager head (10) and the object to be viewed;

- providing the video display screen with a pre-calibrated scale means (29) so that the location of the auxiliary image (21, 66) can be quantized as a magnification factor of the image of the object displayed on the video display screen; and,
 - calculating the actual size of the object viewed on the video display screen by dividing a measured length of the image of the object on the video display screen by the magnification factor indicating the location of the auxiliary image (21, 66) on the pre-calibrated scale means, said calculating being unaffected by the orientation of the plane containing the object relative to the optical axis of the lens system (16).
9. The method of claim 8, further characterized by the step of measuring the length of the image of the object on the video display screen by electronically counting the number of pixels along the length of the image of the object on the screen.
10. The method of claim 8, further characterized by the step of providing the pre-calibrated scale means (29) with numerical indicia indicating the actual distance between the borescope imager head (10) and the object to be viewed so that the difference between the numerical indicium indicating one edge of the object and the numerical indicium indicating the other edge of the object results in the actual length of the object when the object is in a plane substantially perpendicular to the optical axis of the lens system (16).
2. Vorrichtung zum Messen der tatsächlichen Größe eines Objektes, welches mit einem Video-Anzeigesystem dargestellt ist, wie in Anspruch 1 beschrieben, dadurch gekennzeichnet, daß die tatsächliche Größe des Objektes durch Dividieren der Größe des Bildes des Objektes, wie sie auf dem Schirm gemessen wird, durch den ermittelten Vergrößerungsfaktor berechenbar ist.
3. Vorrichtung zum Messen der tatsächlichen Größe eines Objektes, welches mit einem Video-Anzeigesystem dargestellt ist, wie in Anspruch 1 beschrieben, dadurch gekennzeichnet, daß die tatsächliche Größe des Objektes durch Subtrahieren des der Skala (29) entnommenen Objektabstandes, der einem Ende des Bildes des Objektes auf dem Schirm zugeordnet ist, von dem Objektabstand, der dem anderen Ende des Bildes des Objektes zugeordnet ist, berechenbar ist, wenn sich das dargestellte Objekt in einer zur optischen Achse des Linsensystems (16) im wesentlichen senkrechten Stellung befindet.
4. Vorrichtung zum Messen der tatsächlichen Größe eines Objektes, welches mit einem Video-Anzeigesystem dargestellt ist, wie in einem der Ansprüche 1 bis 3 beschrieben, dadurch gekennzeichnet, daß die Beleuchtungsquelle (12) einen dünnen Streifen aus fiberoptischem Material (19) umfaßt, dessen Breite wesentlich größer ist als seine Dicke, und daß die genannten Zusatzbild-Erzeugungsmittel (20,52) einen Schattenbalken (20) umfassen, der eng neben dem Ende des genannten dünnen fiberoptischen Streifens (19) angeordnet und zur Mittellinie des beleuchteten Feldes versetzt ist, so daß eine Schattenlinie (21) auf dem dargestellten Objekt und in dessen auf dem Video-Bildschirm angezeigten Bild erzeugt wird.
5. Vorrichtung, wie in einem der Ansprüche 1 bis 3

Patentansprüche

1. Vorrichtung zum Messen der tatsächlichen Größe eines Objektes, welches auf einem Video-Bildschirm dargestellt ist, bei der eine Beleuchtungsquelle (12,40) für das Objekt und ein Boroskop-Bildaufnahmekopf (10) in einem Gehäuse angeordnet und an ein Video-Anzeigesystem angeschlossen sind, welches den genannten Video-Bildschirm enthält, wobei die Vorrichtung die folgenden Merkmale umfaßt:
- Zusatzbild-Erzeugungsmittel (20,52), die dem Boroskop-Bildaufnahmekopf (10) zugeordnet sind, um ein Zusatzbild (21,66) auf das darzustellende Objekt zu projizieren, wobei die genannten Bilderzeugungsmittel (20,52) derart angeordnet sind, daß sie eine Änderung der Größe des erzeugten Zusatzbildes (21,66) in Proportion zu dem Abstand, den das zu messende Objekt von dem Boroskop-Bildaufnahmekopf (10) hat, zu bewirken, wobei die genannte Änderung der Größe mit einer Änderung der Lage des Zusatzbildes (21,66) auf dem Video-Bildschirm korrespondiert; und
 - eine vorgeeichte Skala (29), die auf den Video-Bildschirm überlagert wird, um die Lage des Zusatzbildes (21,66) auf dem Schirm zu identifizieren und den Vergrößerungsfaktor zu ermitteln, der der identifizierten Lage des Zusatzbildes auf dem Schirm zugeordnet ist, so daß der genannten Skala der Abstand des Objektes zu dem Boroskop-Bildaufnahmekopf (10) entnehmbar ist, unabhängig von der Orientierung der das Objekt enthaltenden Ebene relativ zu der optischen Achse des Linsensystems (16).

beschrieben, dadurch gekennzeichnet, daß die Zusatzbild-Erzeugungsmittel (20,52) eine Quelle für farbiges, kohärentes, laserähnliches Licht (52) umfassen, welches projiziert wird, um einen Ring aus kohärentem, laser-ähnlichem Licht mit konstantem Durchmesser auf dem darzustellenden Objekt und in dessen auf dem Video-Bildschirm angezeigten Bild zu erzeugen.

6. Vorrichtung, wie in einem der Ansprüche 1 bis 5 beschrieben, dadurch gekennzeichnet, daß die genannte vorgeeichte Skala (29) in Abhängigkeit von dem jeweiligen Video-Bildschirm und den Geometrien des jeweiligen Boroskop-Bildaufnahmekopfes (10), der jeweiligen Beleuchtungsquelle (12,40), der jeweiligen Bildaufnahmelinse (15,42) und des jeweiligen Aufnahmesystems, wie z.B. des Videobild-Aufnahmekanals (14), geeicht ist.

7. Vorrichtung, wie in einem der Ansprüche 1 bis 6 beschrieben, gekennzeichnet durch eine Schaltung, die Positionsanzeiger (32,34) einschließt, zur Durchführung der Messung des auf dem Video-Bildschirm dargestellten Bildes des Objektes, indem die Pixel zwischen den Positionsanzeigern (32,34) elektronisch gezählt werden, wenn jeder der Positionsanzeiger (32,34) an einem der einander gegenüberliegenden Enden des zu vermessenden Durchmessers des Objektbildes positioniert ist.

8. Verfahren zum Messen der tatsächlichen Größe eines Objektes, das auf einem Video-Bildschirm dargestellt wird, der mit einem Boroskop verbunden ist, welches eine allgemeine Beleuchtungsquelle (12,40) und eine Bild-Erfassungsvorrichtung (14) aufweist, die in einem Boroskop-Bildaufnahmekopf angeordnet sind, der an dem vorderen Ende eines Boroskop-Einführungsrohres oder -schlauchs (46) befestigt ist, welches Verfahren die folgenden Schritte umfaßt:

- Erzeugung eines Zusatzbildes (21, 66) entweder durch Anordnung eines Schattenbalkens (20) zwischen der allgemeinen Beleuchtungsquelle (12) und dem darzustellenden Objekt, um ein Zusatzbild (21) zu erzeugen, oder durch Anordnung einer Quelle für farbiges, kohärentes, laser-ähnliches Licht (52) um die allgemeine Beleuchtungsquelle (40) herum, um das Zusatzbild (66) zu erzeugen;
- Projizieren des Zusatzbildes (42, 66) auf das darzustellende Objekt;
- Anzeigen des Bildes des Objektes und des Zusatzbildes (21,66), welche von der Erfassungsvorrichtung (14) aufgenommen

werden, auf einem Video-Bildschirm;

- Schaffen einer Lageänderung des Zusatzbildes (21,44) auf dem Video-Bildschirm in Abhängigkeit von dem Abstand zwischen dem Boroskop-Bildaufnahmekopf (10) und dem darzustellenden Objekt;
- Ausstatten des Video-Bildschirmes mit einer vorgeeichten Skala (29), so daß die Lage des Zusatzbildes (21,66) als Vergrößerungsfaktor des auf dem Video-Bildschirm angezeigten Bildes des Objektes quantisiert werden kann; und
- Berechnung der tatsächlichen Größe des auf dem Video-Bildschirm dargestellten Objektes durch Dividieren einer gemessenen Länge des Bildes des Objektes auf dem Video-Bildschirm durch den Vergrößerungsfaktor, der durch die Lage des Zusatzbildes (21,66) auf der vorgeeichten Skala angezeigt ist, wobei die genannte Berechnung von der Orientierung der das Objekt enthaltenden Ebene relativ zu der optischen Achse des Linsensystems (16) unbeeinflusst ist.

9. Verfahren nach Anspruch 8, gekennzeichnet durch den Schritt der Messung der Länge des Objektbildes auf dem Video-Bildschirm durch elektronisches Zählen der Anzahl von Pixeln entlang der Länge des Objektbildes auf dem Bildschirm.

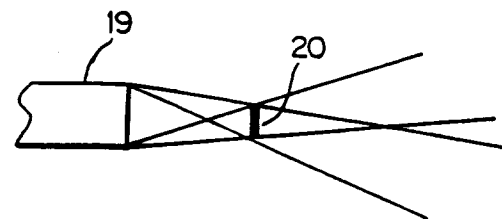
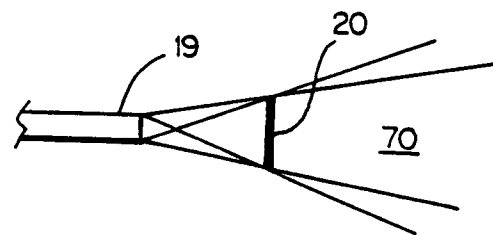
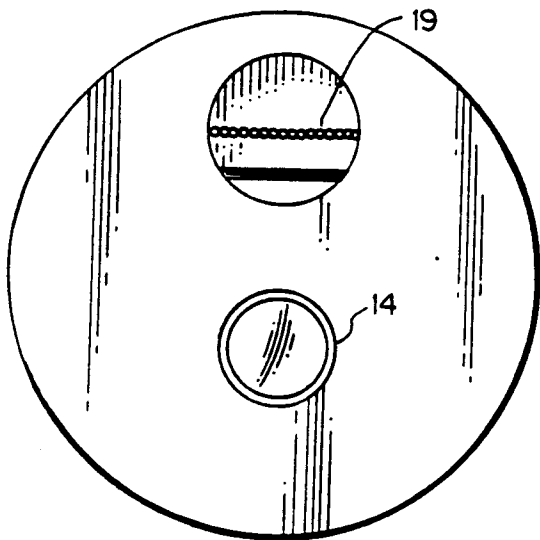
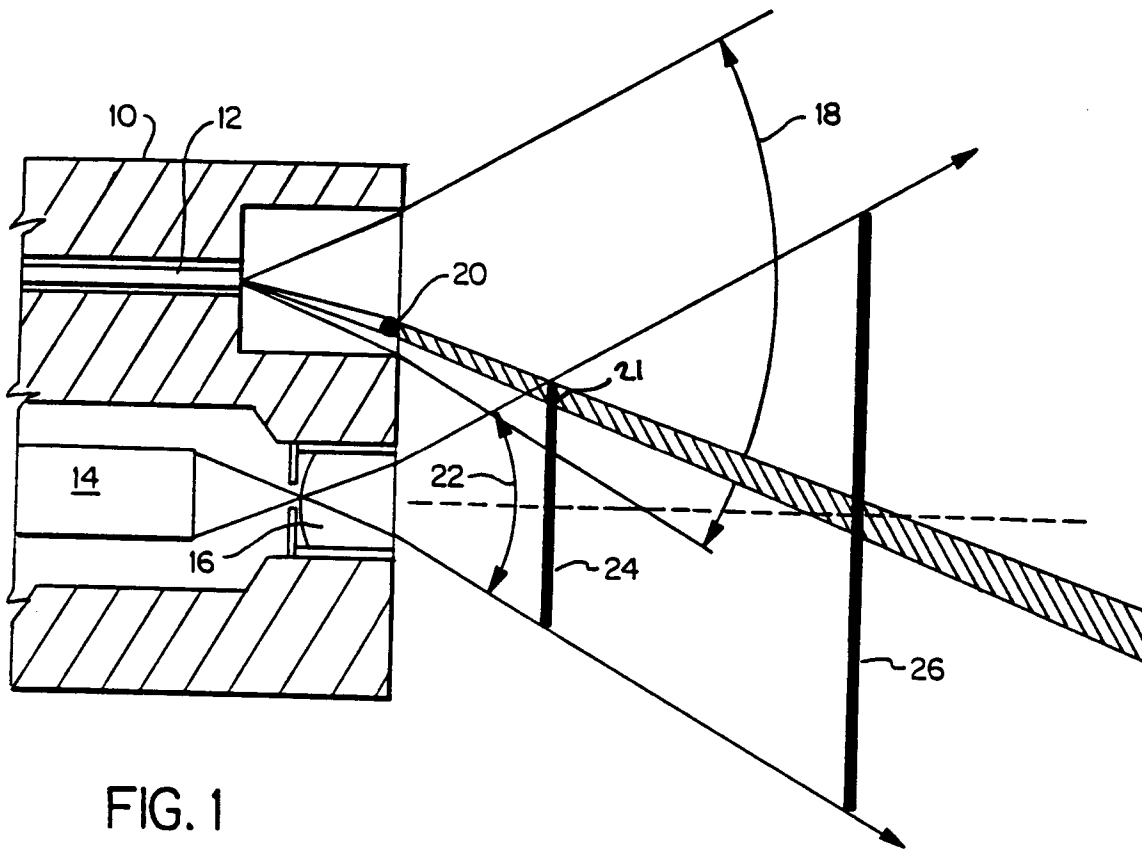
10. Verfahren nach Anspruch 8, gekennzeichnet durch den Schritt, daß die vorgeeichte Skala (29) mit numerischen Markierungen versehen wird, welche den tatsächlichen Abstand zwischen dem Boroskop-Bildaufnahmekopf (10) und dem darzustellenden Objekt anzeigt, so daß die Differenz zwischen der numerischen Markierung, die eine Kante des Objektes indiziert, und der numerischen Markierung, die die andere Kante des Objektes indiziert, in der tatsächlichen Länge des Objektes resultiert, wenn sich das Objekt in einer Ebene befindet, die im wesentlichen senkrecht zur optischen Achse des Linsensystems (16) verläuft.

Revendications

1. Système pour mesurer la taille réelle d'un objet observé sur un écran de réception vidéo dans lequel une source d'éclairage (12, 40) pour l'objet et une tête de vision d'endoscope (10) sont disposées dans un boîtier et reliées en fonctionnant à un système de réception vidéo comportant ledit écran de réception vidéo, comprenant
- un moyen de création d'une image auxiliaire

- re (20, 52) associé en fonctionnement à la tête de vision d'endoscope (10) pour projeter une image auxiliaire (21, 66) de l'objet à observer, ledit moyen de création d'une image (20, 52) étant disposé de telle sorte que l'image auxiliaire créée (21, 66) change de taille en fonction de la distance à laquelle se trouve l'objet à mesurer par rapport à la tête de vision d'endoscope (10), ledit changement de taille correspondant à un changement de position de l'image auxiliaire (21, 66) sur l'écran de réception vidéo, et
- une échelle préétalonnée (29) recouvrant l'écran de réception vidéo pour identifier la position de l'image auxiliaire (21, 66) sur l'écran et pour déterminer le grossissement associé à la position identifiée de l'image auxiliaire sur l'écran de telle sorte que la distance qui sépare l'objet de la tête de vision d'endoscope (10) peut être obtenue à partir de ladite échelle indépendamment de l'orientation du plan contenant l'objet par rapport à l'axe optique du système de lentilles (16).
2. Le système pour mesurer la taille réelle d'un objet observé sur un écran de réception vidéo tel que décrit dans la revendication 1, caractérisé en outre en ce que la taille réelle de l'objet peut être calculée en divisant la dimension de l'image de l'objet mesurée sur l'écran par la valeur déterminée du grossissement.
 3. Le système pour mesurer la taille réelle d'un objet observé sur un écran de réception vidéo tel que décrit dans la revendication 1, caractérisé en outre en ce que la taille réelle de l'objet peut être calculée en soustrayant la distance de l'objet sur l'échelle (29) qui est associée à une extrémité de l'image de l'objet sur l'écran, de la distance de l'objet associée à l'autre extrémité de l'image de l'objet lorsque l'objet observé est dans une position substantiellement perpendiculaire à l'axe optique du système de lentilles (16).
 4. Le système pour mesurer la taille réelle d'un objet observé sur un écran de réception vidéo tel que décrit dans l'une quelconque des revendications 1 à 3, caractérisé en outre en ce que la source d'éclairage (12) comporte une bande étroite de matériau en fibre optique (19) ayant une largeur substantiellement plus grande que son épaisseur, et en ce que ledit moyen de création d'une image auxiliaire (20, 52) comprend une barre d'ombrage (20) positionnée très près de l'extrémité de ladite bande étroite de matériau en fibre optique (19) et décalée de l'axe du champ d'éclairage de telle sorte qu'une ligne d'ombre (21) est créée sur l'objet en cours d'observation et sur son image projetée sur l'écran de réception vidéo.
 5. Le système tel que décrit dans l'une quelconque des revendications 1 à 3, caractérisé en outre en ce que le moyen de création d'une image auxiliaire (20, 52) comprend une source de lumière colorée cohérente de type laser (52) projetée pour former un anneau de diamètre constant de lumière cohérente de type laser (66) sur l'objet à observer, et sur son image projetée sur l'écran de réception vidéo.
 6. Le système tel que décrit dans l'une quelconque des revendications 1 à 5, caractérisé en outre en ce que l'échelle préétalonnée (29) est étalonnée en fonction de l'écran de réception vidéo spécifique et de la géométrie de la tête de vision de l'endoscope (10) spécifique, de la source d'éclairage (12, 40), des lentilles de vision (15, 42) et d'un système détecteur tel qu'un canal de détection d'image vidéo (14).
 7. Le système tel que décrit dans l'une quelconque des revendications 1 à 6, caractérisé en outre en ce qu'il comprend un circuit avec des curseurs (32, 34) pour effectuer la mesure de l'image de l'objet projetée sur l'écran de réception vidéo en comptant électroniquement les pixels entre les curseurs (32, 34) lorsque chacun des deux curseurs (32, 34) est positionné à l'une des extrémités opposées du diamètre de l'image de l'objet que l'on veut mesurer.
 8. Méthode de mesure de la taille réelle d'un objet observé sur un écran de réception vidéo associé à un endoscope ayant une source d'éclairage général (12, 40) et un dispositif de détection d'image (14) placé dans la tête de vision (10) d'un endoscope monté à l'extrémité distale du tube d'insertion (46) de l'endoscope, ladite méthode comprenant les étapes de :
 - création d'une image auxiliaire (21, 66) soit par interposition d'une barre d'ombrage (20) entre la source d'éclairage général (12) et l'objet à observer pour créer l'image auxiliaire (21), soit par superposition d'une lumière colorée cohérente de type laser (52) autour de la source d'éclairage général (40) pour créer l'image auxiliaire (66),
 - projection de l'image auxiliaire (21, 66) en direction de l'objet à observer,
 - affichage de l'image de l'objet et de l'image auxiliaire (21, 66) reçue par le dispositif de détection (14) sur l'écran de réception vidéo,

- changement de position de l'image auxiliaire (21, 66) sur l'écran de réception vidéo en fonction de la distance qui sépare la tête de vision d'endoscope (10) de l'objet à observer, 5
 - placement sur l'écran de réception vidéo d'une échelle préétalonnée (29) de telle sorte que la position de l'image auxiliaire (21, 66) puisse être quantifiée sous forme de valeur de grossissement de l'image de l'objet projetée sur l'écran de réception vidéo, et 10
 - calcul de la taille réelle de l'objet observé sur l'écran de réception vidéo en divisant la longueur de l'image de l'objet mesurée sur l'écran par la valeur déterminée du grossissement indiquant l'emplacement de l'image auxiliaire (21, 66) sur l'échelle préétalonnée, ledit calcul n'étant pas influencé par l'orientation du plan contenant l'objet par rapport à l'axe optique du système de lentilles (16). 15 20
9. La méthode de la revendication 8, caractérisée en outre en ce que l'étape de mesure de la longueur de l'image de l'objet sur l'écran de réception vidéo s'effectue par un comptage électronique du nombre de pixels sur la longueur de l'image de l'objet à l'écran. 25 30
10. La méthode de la revendication 8, caractérisée en outre en ce que dans l'étape de placement sur l'écran de réception vidéo d'une échelle préétalonnée (29), un index numérique indique la distance réelle entre la tête de vision d'endoscope (10) et l'objet à observer de telle sorte que la différence entre l'index numérique correspondant à l'un des bords de l'objet et l'index numérique correspondant à l'autre bord de l'objet donne la longueur réelle de l'objet lorsque l'objet se situe dans un plan substantiellement perpendiculaire à l'axe optique du système de lentilles (16). 35 40 45 50 55



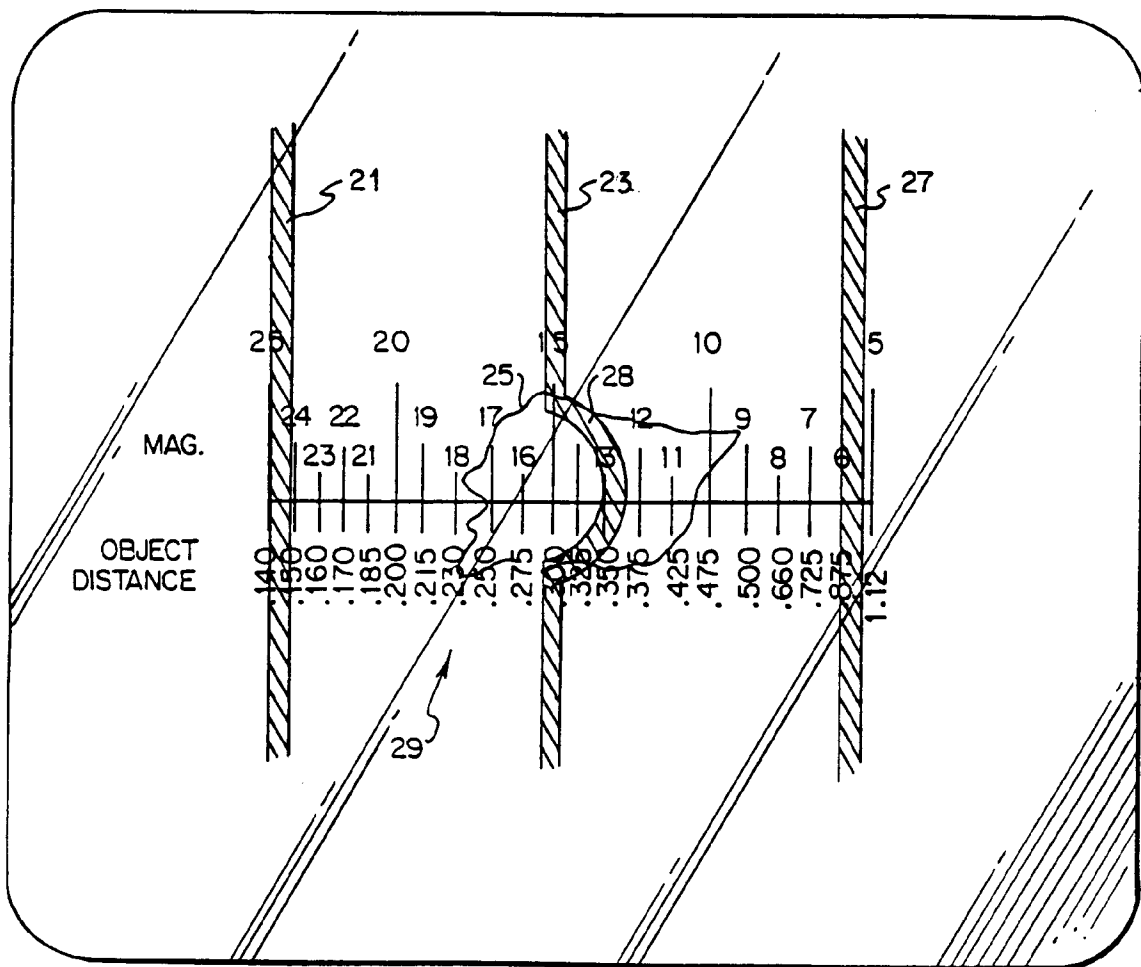


FIG. 3

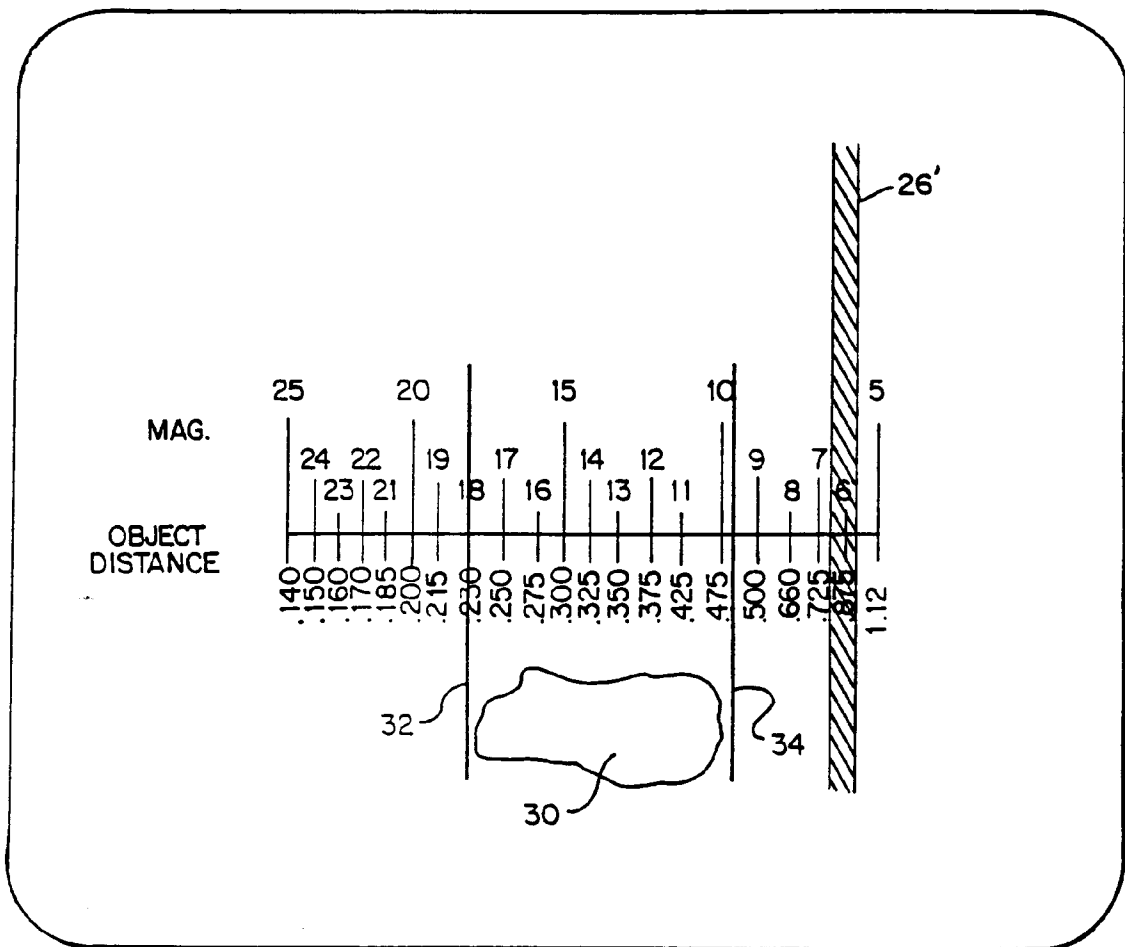
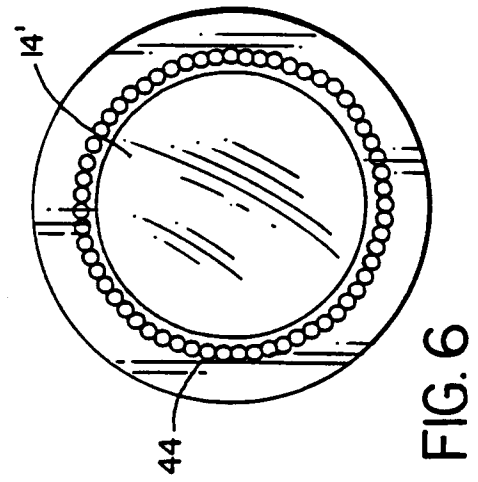
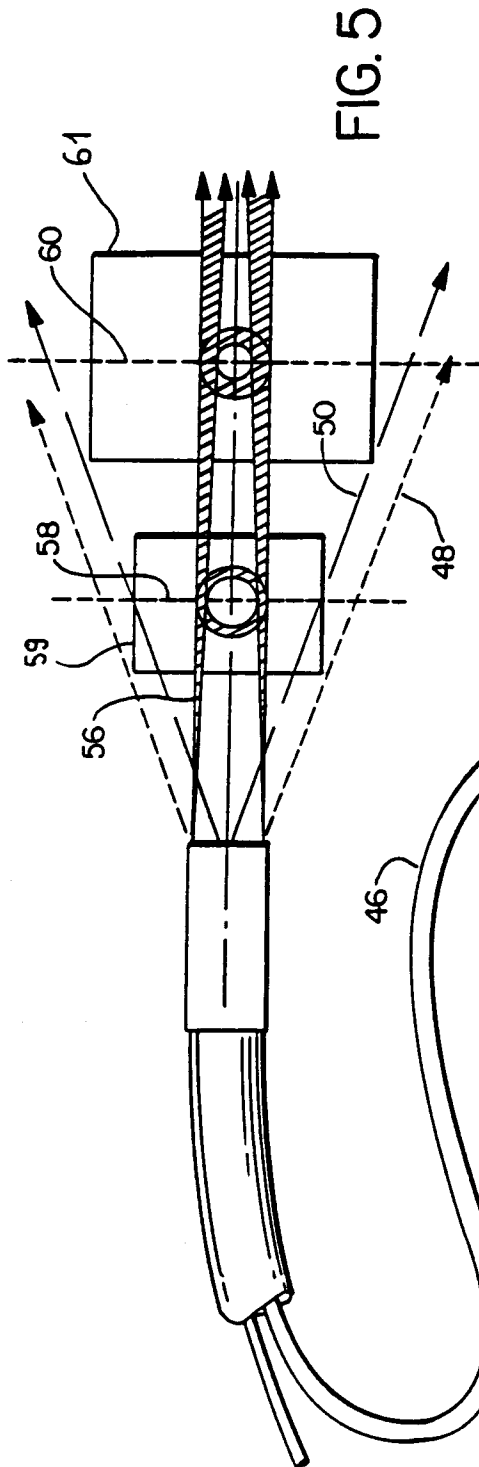


FIG. 4



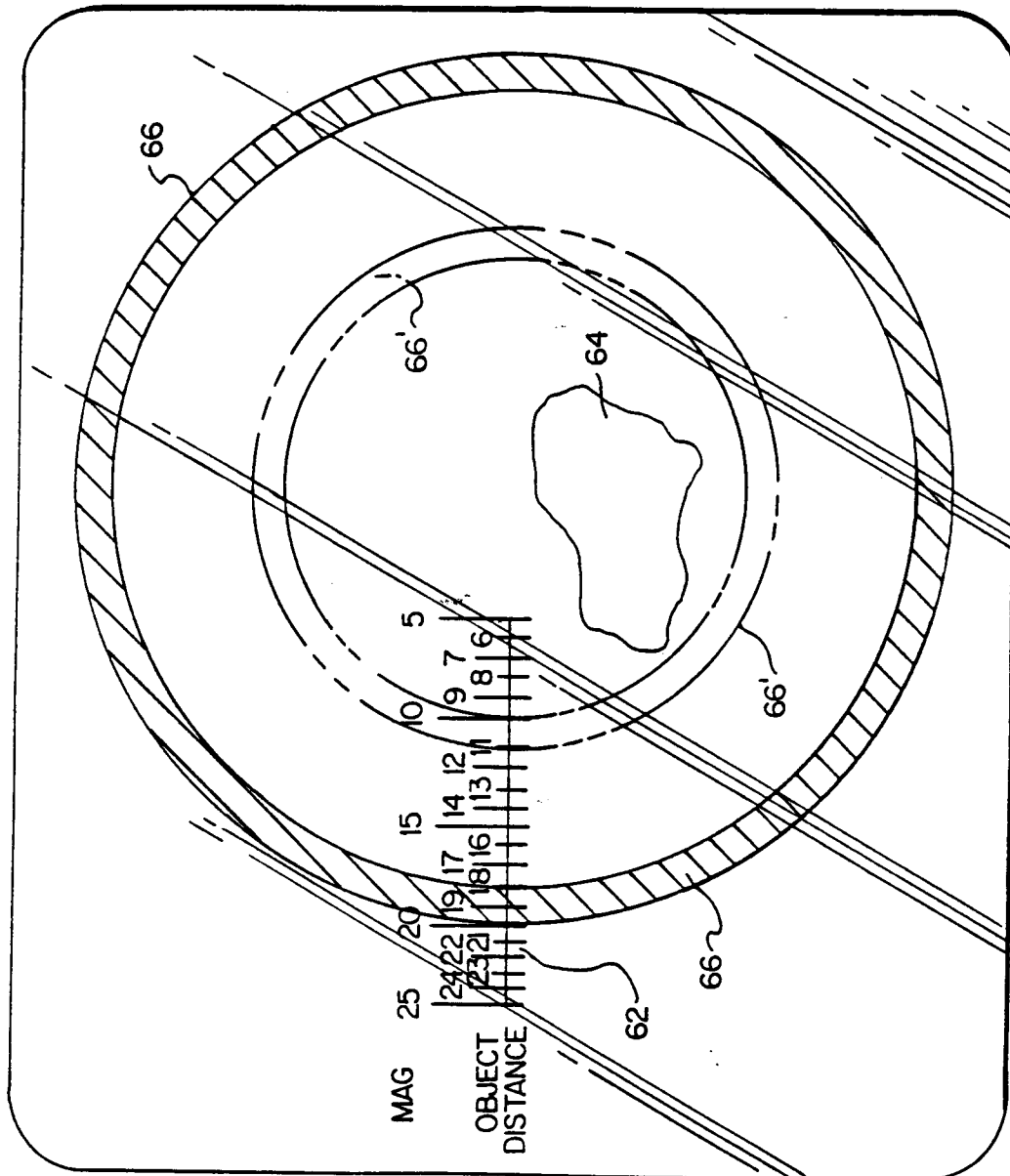


FIG. 7